ABSTRAK

Penelitian ini bertujuan untuk mengkaji karakteristik, aktivitas antibakteri, serta kinerja membran filtrasi nanokomposit Kitosan/PEG/*Multi Wall Carbon Nanotube* (MWCNT) /Benzalkonium Klorida. Benzalkonium Klorida (BZK) digunakan sebagai agen antibakteri yang di inkorporasi pada membran filtrasi Kitosan/PEG/MWCNT. Penelitian ini terdiri dari tahap preparasi, uji karakterisasi, uji aktivitas antibakteri, serta uji kinerja membran. Membran nanokomposit Kitosan/PEG/MWCNT/BZK disintesis menggunakan metode inversi fasa. BZK ditambahkan pada membran nanokomposit Kitosan/PEG/MWCNT secara *in-situ*. Karakterisasi membran dilakukan menggunakan FTIR, SEM, pengujian kekuatan mekanik dan elongasi, penentuan % porositas serta hidrofilisitas membran. Pengujian aktivitas antibakteri dilakukan terhadap bakteri *Staphylococcus aureus* dan *Escherichia coli* melalui metode cincin inhibisi (Kirby Bauer) dan *Total Plate Counting* (TPC). Kinerja membran diuji melalui pengukuran fluks dari filtrasi air murni menggunakan set alat filtrasi *dead-end*. Hasil penelitian menunjukkan bahwa BZK berinteraksi dengan prekursor membran melalui gugus C-O, hal ini ditunjukkan dengan pergeseran pita serapan spektra IR dari 1093,6 cm^{-1} (membran tanpa BZK) menjadi 1110,9 cm^{-1} (membran dengan penambahan BZK). Berdasarkan observasi gambar SEM, membran dengan penambahan BZK memiliki diameter pori permukaan yang lebih besar. Penambahan BZK pada membran nanokomposit Kitosan/PEG/MWCNT dapat meningkatkan sifat fisika-kimia membran, antara lain meningkatkan elastisitas membran dengan meningkatnya % *elongation at break* (19,87% menjadi 69,87%), porositas membran (64,8% menjadi 65,3%), dan ukuran pori membran/*average pore radius* (8.8 nm menjadi 27 nm). Disisi lain, penambahan BZK pada membran Kitosan/PEG/MWCNT menyebabkan kekuatan mekanik membran menurun dengan menurunnya harga *tensile strength* (0,031 Kg/mm^2 menjadi 0,025 Kg/mm^2), dan hidrofilisitas membran dengan meningkatnya nilai *contact angle* membran (θ = 60,274° menjadi 72,45°). Aktivitas antibakteri membran nanokomposit Kitosan/PEG/MWCNT/QAC mulai terlihat pada konsentrasi BZK 10 ppm terhadap bakteri *S. aureus* dan 150 ppm terhadap bakteri *E. coli*. Aktivitas antibakteri meningkat seiring dengan meningkatnya konsentrasi BZK. Membran nanokomposit tanpa BZK memiliki *Bacteria Killing Ratio* (%BKR) masing-masing 2,56% dan 16,8% terhadap bakteri *S. aureus* dan *E. coli*. Membran nanokomposit Kitosan/PEG/MWCNT/BZK dengan aktivitas antibakteri mulai terlihat (10 ppm dan 150 ppm) memiliki %BKR 43,3% terhadap bakteri *S. aureus* dan 90,9% terhadap bakteri *E. coli*. Penambahan BZK terhadap membran nanokomposit Kitosan/PEG/MWCNT dapat meningkatkan nilai fluks membran (23,59 $L.m^{-2}.Jam^{-1}$ – 27,45 $L.m^{-2}.Jam^{-1}$).

Kata Kunci: Kitosan, PEG, MWCNT, membran nanokomposit, filtrasi

ABSTRACT

This research aims to evaluate the characteristics, antibacterial activity, and performance of nanocomposite Chitosan / PEG / Multi Wall Carbon Nanotube (MWCNT) / Benzalkonium Chloride filtration membrane. Benzalkonium Chloride (BZK) was used as an antibacterial agent and incorporated to chitosan / PEG / MWCNT filtration membrane. The research method included preparation, characterization, antibacterial activity, and membrane performance assay. The chitosan / PEG / MWCNT / BZK nanocomposite membrane was synthesized using phase inversion method. BZK was added in situ to Chitosan / PEG / MWCNT nanocomposite membrane. Characterization of nanocomposite membrane was carried out by FTIR, SEM, mechanical strength, % porosity, and hydrophilicity measurement. The antibacterial activity assay was conducted using disk diffusion Kirby Bauer and Total Plate Counting (TPC) method against against Staphylococcus aureus and Escherichia coli. The performance of nanocomposite membrane is determined by measuring the pure water flux using a set of dead-end filtration. The results showed that BZK interact with membrane precursors through the C-O group, this is indicated by a shift in absorption band) in the IR spectra (from 1093.6 cm^{-1} ¬ (membrane without BZK) to 1110.9 cm^{-1} (Membrane with BZK). Based on SEM image observation, chitosan / PEG / MWCNT / BZK membrane has a larger surface pore diameter. BZK addition to nanocomposite membrane can improve physical-chemical properties of the membrane, such as elasticity with increasing % elongation at break (19.87% to 69.87%), porosity (64.8% to 65.3%), and average pore radius (8.8 nm to 27 nm). On the other hand, the addition of BZK to Chitosan / PEG / MWCNT membrane decrease the mechanical strength (0,031 kg / mm^2 to 0,025 kg / mm^2), and hydrophilicity of the membrane with the increasing value of the contact angle of the membrane (θ= 60.274 ° to 74,70 °). The antibacterial activity of the chitosan / PEG / MWCNT / BZK was appeared at 10 ppm against S. aureus and 150 ppm against E. coli. Antibacterial activity linearly increased with addition of BZK concentration. Bacteria Killing Ratio (% BKR) of the composite membrane without BZK was 2.56% and 16.8% of S. aureus and E. Coli, respectively. Meanwhile, %BKR of Chitosan / PEG / MWCNT / BZK membrane at antibacterial activity appeared (10 ppm and 150 ppm) was 43.3% against S. aureus and 90.9% against E. Coli. Addition BZK into membrane also increase the value of pure water flux membrane (23,59 $L.m^{-2}.h^{-1}$ to 27.45 $L.m^{-2}.h^{-1}$)

Keywords: *Chitosan, PEG, MWCNT, nanocomposite membrane, filtration*